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ABSTRACT

The purpose of an instructional system is to bring about specific changes in the capabilities of individuals; that is, their potential performance of certain intellectual or motor activities. Achievement and attitudes of learners entering into instruction constitute the input of the system, while their change capabilities are the output. Because there are different ways to ask people to do a specific thing, designers may use different instructional activities for the same system function. Instructional theory describes the reality of instructional systems and theory must describe reality in such a way that hypotheses can be inferred and tested. The three corporate sources for knowledge about instruction are practice, empirical research, and deductive theory. It is questionable, with all the variables and different methods available, that there will ever be one integrated theory of instructional design developed, based solely on knowledge of human learning and functioning as a useful tool for designers of all types of instruction, or a yardstick for criticizing instructions developed by others. (CB)

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THE KNOWLEDGE BASE FOR INSTRUCTIONAL DESIGN

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The boundaries of our knowledge

As a member of a team of pioneers founding a new university department for the training of R & D professionals six years ago my assignment was the preparation of a program for prospective instructional designers. In doing so I noticed a discrepancy between the knowledge about instruction found at our disposal in textbooks and summary articles and the knowledge we should like to open up for our students. I experienced a gap between the body of knowledge about instruction and the knowledge we should like our students to have at their disposal once they would be called to solve problems in practice. During our preparatory work I got the impression that there existed more knowledge than trainers and educators had access to and that the body of knowledge could grow faster than it seemed to do.

I also gradually began to understand that in theoretical writings knowledge about instruction seldom seems to be considered as "knowledge of the artificial" and that most authors concentrate on problems of learning and thinking of human beings, thus leaving out the chance to describe the very phenomena that occur in instruction. This, in my opinion, seemed to be the true reason for the unhappy fact that the steadily growing group of instructional designers in business and industry worked within a rather narrow domain of real knowledge about instruction. It seemed to me that the boundaries of their knowledge could be made much wider.

Instruction as the subject of inquiry

If we are willing to consider instruction as the subject of inquiry, then we commit ourselves to observation, description and prediction of phenomena in instruction. There are many different types of instructional variables and some of them must have been well known from the beginning of human civilization: teacher behavior, physical surroundings, student characteristics, interactions between student and instructor, media, educational objectives, and all those other instructional elements and aspects which are so often mentioned by both experts and laymen interested in the structure and the functions of schools and training departments. If we think about instruction along these lines, it seems only logical to speak of "instructional systems" instead of instruction. Thus we indicate that our subject of inquiry is manmade and artificial. Consequently, knowledge about instruction should pertain to the goals, structure, and functioning of instructional systems within their environment. But what are instructional systems? And what is the definition of instruction?

It seems difficult to investigate or to design instruction without presuming that it takes place within an instructional system. Indeed, I can hardly imagine that speaking of instruction per se does suffice for those who wish to extend the knowledge base for instructional designers. The purpose of an instructional system is to bring about specific changes in the capabilities of human beings; that is, their potential performance of certain intellectual or motor activities. Achievement and attitudes of learners entering into instruction could be

considered as the input of the system. Their changed capabilities are the output. Almost always the functions of a system can be considered as deliberately sought influence on the learner, which can be characterized by authoritarian verbs but also by the rather permissive verb "to ask". Instruction may ask learners to read the study material, may ask them to listen to recorded or live lectures, may ask them to pose questions,to summarize, review, excercise intellectual or motor skills.

Because there are different ways to ask people to do a specific thing, designers may use different instructional activities for the same system function. Systematic investigation of instructional systems presumes a theory. What kind of theory is that?

Instructional theory in the first place describes the reality of instructional systems. Instructional theory - like any other theory - will contain a comprehensive set of propositions about what its subject looks like and how it works. The theory must describe reality in such a way that hypotheses can be inferred and tested. What type of statements do we find if we search for existing instructional theory? Because instruction is mostly given to groups, it is no wonder that in the literature about instruction many empirically based theses are to be found about the structure and relationships between variables of the classroom as an instructional system. Teacher behavior variables thus get much attention. On the other hand, in places where written material is available and the use of computers as instructors is growing, more attention is given to the phenomena in individualized instructional systems where the student works with a learning package or interacts with the computer.

Let me make two additional remarks here about the question of the

subject of inquiry. First I would like to mention that many of those engaged in instructional design, hold another idea of instructional theory, stating that such a theory gives prescriptions for instruction. I wouldn't venture to object to this widespread use of the word. All authors state explicitly the normative nature of the conceived theory. What I try to do in this paper is to present some preliminary reflections on the age-old descriptive, explanatory and predictive connotations of the word theory. This is especially important if our purpose should be to nurture a theory of instruction which may serve as a long lasting future knowledge base for instructional designers. Second, let me observe that the conception of instruction as a legitimate subject of inquiry does neither treat the student by necessity as a black box, nor does it hold that - though it has to consider that the learner is only one of the elements within the system - the cognitive processes are to be neglected and that only overt behavior is relevant.

If we wish to describe and predict phenomena in instructional systems, what types of sources are at our disposal?

Three corporate sources for knowledge about instruction

All relevant statements about instructional phenomena could be classified as originating from practice, from empirical research, or from deductive theory. I believe that those who wish to develop instructional theory have to reckon with the fact that development of knowledge is a matter of collecting and integrating results from these three different sources. Knowledge about instruction does not seem to me

to be exclusively experiential, or empirical, or deductive.

The experience of teachers, trainers and other developers of instruction is one of the richest sources for hypothetical knowledge about instruction. Many scientists are careful with or even sceptical about observational data from practioners. On the other hand, alleged misconceptions, prejudice, or faulty observation of practioners may not prevent us from attaching much value to the statements of practioners about the phenomena in instruction. Practioners, as participant observers, observe the phenomena from close by. Much of their knowledge, sometimes after translation in the scientific terminology and sometimes tested under experimental conditions, is or may rightfully be added to our description of instructional systems. A theory of instruction could not exist if it did not make use of the accumulated wisdom, the discoveries, and the inventions of practioners.

In principle, scientific knowledge starts with the careful observation and registration of phenomena. This also seems to be true for instruction. The problem with instruction is, that the observations are scattered and must be sought in fields differing in terminology, extension, and methodology. The fields differ also in the aspects of instruction that they are interested in. Thus they concentrate often on one of widely different themes such as: teacher behavior, textbook illustrations, audiovisual equipment, or student learning styles.

Deductive theoretical statements about instruction provide us with models of the relationships between instructional methods and learning outcomes. A theory can also encompass initial student ability or knowledge and in that case it is presumed that the designer or the user of the design has at his disposal measures of these student characteristics. Deductive theory can concentrate on certain aspects of

the instruction, like the strategies of the teacher, the structure of the subject matter, or the interaction in the classroom. In general, theories give general statements about the relationships within the instructional system, from which no consequences for individuals can be drawn.

A mature theory of instruction will use the three sources mentioned. One could guess that experiential knowledge about instruction and deductively theorizing about what takes place in instructional systems always precedes the empirical approach in which structure and functions of the system are described. But in a mature theory empirical evidence will have a major influence on the body of knowledge that instructional designers can use in their work. In this way the description of reality will reconcile the two contrasting approaches. It will solve the discrepancy between the bottom up approach of the practical educators and the top down attitude of the academic instructional theorist. Both theoretical and practical notions about instruction can be tested by rigorous observations and experiments. The results from empirical work will have their influence on theory builders and practicioners. So in the end we prefer to speak here about corporate sources for our knowledge base: practice, induction, and deduction.

What can be prescribed?

Instructional designers have been discussing the difference between description and prescription for more than twenty years. I believe that all the time this discussion has centered on only one element in the system: the learner. He has drawn the most attention in the debate. This

meant that the knowledge base for instructional designers gradually was built up as a body of knowledge about thinking and learning of human beings. The problem for designers is, that there is no direct link between that knowledge and instruction. But a solution can be sought for every problem. The gap could have been filled in these twenty years by some kind of interpreter or middleman or by an integrated set of prescriptions and recipes connecting cognitive science and educational practice. But what type of prescriptions can a translater give, on the basis of knowledge about human thinking or memory? What type of prescriptive knowledge can we expect to develop?

I recognize that instructional designers use cognitive psychological knowledge, and I know that instructional design theory has made great strides in applying that knowledge to the teaching of young children. However, at the same time we have to face the fact that most of our designed instructions in training situations in business and industry are not based on a prescriptive theory originating from this psychological knowledge. Most textbooks, courses, and training in practice are developed on the basis of behavioral science and past experience of the designer, the latter sometimes legitimated by a bow toward some seemingly scientific theory. I do not consider this a disaster. Instruction, like every other goal directed human activity, had to start its history as a set of techniques or strategies. Systematic description and theorizing come later. After all, Socrates practised inquiry teaching in total ignorance of Collins' theory and generations of teachers gave examples and general statements long before Merrill described his primary presentation forms.

The question remains to be answered, what can be prescibed on the basis of knowledge about human thinking and memory alone. Certainly when

we deal with older students or with training in corporations, taking into account the huge investments, it is relatively little. From the standpoint of the instructional designer, aware of the large gap between theory and practice, this is not amazing. Knowledge about human learning can lead to predictions about dependent variables after manipulating the independent ones, but the independent variables are still within the psychological domain and it is always hard to tell how to manipulate these. You need instruction for that.

Thus the instructional designer or the instructional theorist faces the following predicament. On the one hand there is knowledge about cognitive functioning of learners and the desired changes in knowledge representation in the mind. On the other hand there is the task for the designer to alter the phenomena and to produce output of the instructional system. In his effort to fulfill his duties, the designer finds relatively little help from the cognitive scientist in a form which permits him to translate it into alterable variables within the instructional system.

To me it seems that the solution lies in describing what is going on in instructional systems and providing instructional designers with this description. Is this to be comprised as superficial work and does this mean that we neglect the real reasons why things happen in instruction the way they do? I do not think so. There is much to be discovered within the instructional system, extending our knowledge about why the instructional phenomena do occur the way they do. And coming back to the question what we can prescribe, I would like to say that every sound theory, either describing a natural or an artificial system, allows us to predict what will happen to some elements in the

system if we manipulate variables somewhere in this system. A theoretically or empirically based instructional description can take many forms and consists of statements on and observations of quite different instructions. Thus, it may contain the behavior of an expert (or a novice) teacher or it may contain any of the phenomena in any other instructional system. Predictions or, for that matter, prescriptions can be drawn from such a body of knowledge.

One instructional science or none?

We asked ourselves in the preceding section what kind of prescriptions can be given and the main thing we seem to have been able to do, was to come to the conclusion that prescriptions based on our knowledge of human learning give us a problem. Must we than also conclude that the efforts to develop one presciptive instructional science or one instructional design theory will all be in vain? Maybe there is no straightforward answer possible to this question. Let me express my own uncertainty about the matter.

It seems questionable to me, that there will ever be developed one integrated theory of instructional design, based solely on our knowledge of human learning and functioning as a useful tool to designers of all types of instruction or as a yardstick for criticizing instructions developed by others. I have three arguments supporting that: (a) In the past too little evidence has turned up that this really can be done; (b) it would be necessary to know exactly what is going on in the mind of each learner; and (c) other important elements influencing the phenomena in instruction would be neglected.

All this seems to leave open the possibility of, considering instructional theory as a metatheory or an outline of a metatheory, prescribing the format of useable instructional models. On the other hand, if we stick to our assumption that an instructional theory has aspects in common with all other scientific theories that it describes, explains, and predicts phenomena, then this possibility does not exist. Then we are dealing with a theory about structure and functioning of a system. However, instructional systems are growing and dynamic and in particular they can be divided into groups of different systems, systems in which the interactions between teacher and students are prominent, systems in which the textbook is the main part, and so many other systems, each dealing with its own specific subject. Reasoning like this leads us to the conclusion that there will not be one comprehensive prescriptive theory, but there can be many instructional theories, theories that describe, explain, and make predictions possible. They do though have things in common, which leaves open the chance of one instructional science, on a higher level of abstraction, but not a prescriptive science.

What is new?

Let me finally point out that I am convinced that many others have had similar ideas about the knowledge base for instructional designers. In fact, there are several instances of important movements and work done in this vein. Military task analysis, elaboration theory of instruction and component display theory, mastery learning, inquiry teaching, teacher behavior research, and, more recently, research syntheses, all

give evidence that it is possible to describe and investigate instructional phenomena or present deductive statements about instructional systems. For those who search for it, there is much evidence that instructional problems can be solved by using an instructional theory that deals with structure and phenomena of instructional systems.

I started this paper with a type of needs assessment and I should like to end it in the same vein. Instructional designers do need a knowledge base, like engineers need theirs. Engineering is more than the application of science. It has not been my pretention to prove that in the short run a real instructional theory can be developed. Neither do I pretend to give the outline or the parameters for an instructional theory. One could conclude that in effect my paper does not suggest more than to work on a real instructional theory. Leave psychology alone for the time being, collect what in the course of time has been found about what instruction looks like and how it works, and nurture the theory. That could become something quite new. And that we could use.